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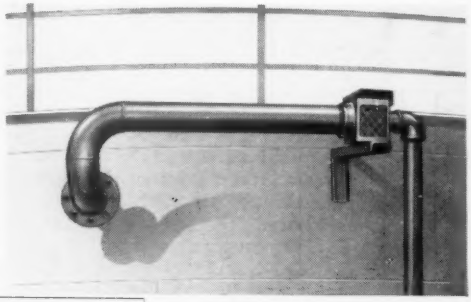

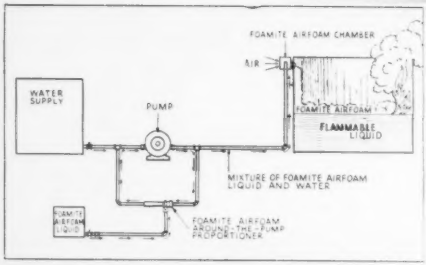

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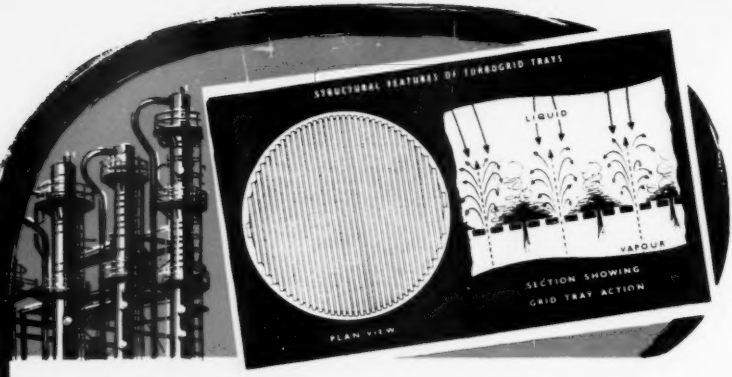

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PETROLEUM WAXES*

By S. T. MINCHIN

The term "wax" is a comprehensive one, of which petroleum waxes form a section only. Waxes are derived from animal, vegetable, and mineral sources. The difference between petroleum and other waxes is that petroleum waxes are complex mixtures of paraffin hydrocarbons, whereas waxes from animal and vegetable sources nearly always contain combined oxygen in the form of acids, alcohols, esters, and so on. In particular, petroleum waxes are complex mixtures of paraffin hydrocarbons that are solid at normal ambient temperatures.

Nearly all crude oils contain fractions of this nature, although the amount varies greatly with different crudes. In some cases the amount may be under 1 per cent, in others there may be 16 per cent or more. In the first case, the wax may quite possibly be regarded as a nuisance; in the second case, it may form a most valuable product.

Wax Distillates

Those paraffins that are solid at ambient temperatures are roughly of the same molecular weight as lubricating oils and distil with them, giving wax distillate, or pressable wax distillate fractions. Some are left in the distillation residue in association with the heavy lubricating oils, the resins, and asphalts. This gives us our first division of the waxes; for, generally, the waxes that are eventually recovered from the wax distillates are the paraffin waxes

*Summary of Paper read to the London Branch IP, 21 January, 1953.

and those eventually recovered from the residues are the microcrystalline waxes.

The separation of waxes from such distillates is accomplished by one of two methods: the pressing and sweating sequences, or solvent dewaxing.

Pressing and Sweating

Separation by the pressing and sweating sequences is carried out first by uniform cooling with slow agitation of the distillate down to a predetermined temperature at which a reasonably fluid slurry of wax in oil is formed. This mixture is then pumped into a filter press in which there may be 500 plates each 4 ft in diameter, the filtering medium being a heavy cable-weave cotton cloth. The filtrate oil falls into a trough and is led off to storage, and a wax cake forms in the cell between the filter cloths, which are held on suitable supports. The pumping is continued until the pressure in the feed line rises to 400 p.s.i. or more. The pressing is then stopped, the press undone and the wax cakes, which may be up to $1\frac{1}{2}$ inch thick, broken up and removed on to a conveyor and transferred to tanks where they are melted and stored for the next stage of the operation. Such cakes contain oil which may vary from about 6 to 35 per cent. This oil-wax mixture from the presses is usually referred to as "slack wax".

The purpose of the next process, sweating, is to remove the residual oil from the wax and also to divide the wax into fractions of varying melting point. The appliances for the separation are many and varied. The so-called tank sweater may be a cylindrical tank, 20 ft or more high, containing a large number of closely spaced vertical water tubes and holding when fully charged with slack wax 20 tons or more. The liquid slack waxes are run into the sweaters and cold water is first passed through the tubes to solidify the charge. When the required degree of solidification is obtained the cooling water is stopped and warm water circulated instead. The temperature of this water is gradually raised, usually at 1 to 3 F per hour.

The result of sweating is that partial liquefaction of the charge is brought about, the lowest setting point constituents melting first and flowing from the solidified mass, carrying with them some of the oil. A better picture of the operation is obtained when we realize that the oil in the solidified mass is held on the crystal surfaces and that when the partial liquefaction occurs, the liquid paraffin dissolves in the oil and the liquid oil wax mixture is thereby pushed through the interstices between the wax crystals and so out to the surface of the mass and thus out of the sweater. In a sense therefore sweating is a continuous washing operation conducted within the mass where the solvent is the wax itself.

It follows that the sweats will contain progressively less oil as the operation proceeds; indeed it may be defined mathematically by $dw/ds = w/l$, where dw/ds is the concentration of the oil in the sweats at any particular stage, and w/l is the concentration of the oil remaining in the liquid held in the mass, the initial weight of starting material being l, the weight of oil at any one stage being w, weight of liquid being l, and the weight of sweats being s.

On integration this gives the equation

$$W_R = C_1 e^{-a(l-s)} - C_2,$$

where W_R is the percentage of oil in the residue; S is the weight sweated from a charge of l, and a, C_1, and C_2 are constants.

Thus, the first stages of the operation yield by far the most oily fractions, the percentage of oil dying away as the sweating proceeds. With a charge of slack wax containing about 6 to 8 per cent of oil, a 30 per cent residue containing less than 0·3 per cent of oil may be obtained in a single straight sweat, providing the appliance is efficient and the operation is carried

out with due regard to such matters as rate of temperature rise and so forth. It is clear that intermediate fractions will be obtained when the oil content is not high enough to reject from the process or low enough to emerge from it as a white wax. Some fractions, therefore, require to be resweated, i.e. they are bulked, resorted, and recycled to sweaters dealing with intermediate fractions until the slack wax has been split into a range of wax fractions of varying setting point on the one hand, and an oil-wax mixture usually containing about 50 per cent of oil on the other. This is rejected from the process and is usually referred to as "sweats rejects" or "foots oil". The remaining wax contained in the foots oil may be recovered in a variety of ways, such as by pressing or recycling the wax distillate stream.

Sweating has been dealt with here at some length because there is surprisingly little data published about the process, especially from the quantitative angle. Undoubtedly a proper quantitative study of most sweating schemes reveals that considerable economies can be effected. Contrary to what appear to be generally accepted opinions, a planned sweating scheme with suitably designed appliances is not inefficient. Normally, in order to obtain 1 part by weight of fully de-oiled wax 4 to 4½ parts of wax have to be sweated; in other words, a substantially complete oil removal is obtained by washing 1 part of wax with 4 to 5 parts of solvent. The pressing and sweating sequences are, however, tending to be superseded by solvent dewaxing, which at least has the merit of being applicable to any wax fraction occurring in petroleum, whereas pressing and sweating apply to distillate fractions only.

Solvent Dewaxing

In solvent dewaxing, the oil-wax mixture is dissolved in a solvent in which the oil is completely soluble, but in which the temperature solubility curve of the wax is very steep, the idea being that cooling will precipitate all the wax and leave all the oil in solution. Various solvents and mixed solvents have been suggested, the most popular being a mixture of methylethyl ketone and benzole, with or without a proportion of toluol.

The wax distillate is dissolved in this solvent and cooled uniformly by mixing to the desired temperature, and the slurry is fed to large rotary filters. The wax cake that is filtered out is washed with fresh or partially used solvent, repulped, or recrystallized, refiltered, and again washed, until the solvent-free wax and oils are of the required properties, the wax being fully de-oiled as in the sweating process.

When the process is applied to distillation residues, the residue is usually first de-asphaltized, often solvent extracted, and the de-asphaltized and extracted product is the oil-wax mixture passed to the solvent dewaxing plant. The waxes recovered from such mixtures are, as mentioned, microcrystalline.

Other separating processes are also employed, but those described here are more widely used. Waxes are also recovered in certain cases from the waxy sludge removed from wells; these are refined to so-called Rod Waxes, and are of very high setting point. The yield of such products is small.

The waxes obtained from these various processes require a finishing treatment, the object of which is to reduce and stabilize the colour, and remove all traces of odour. Usually the finishing treatment is by filtration through a suitable adsorbent, such as bauxite, or fuller's earth; but an acid treatment is preferred by some producers.

Refined Waxes Categories

As has already been indicated, the refinery procedures have produced (as a rule) paraffin waxes from the distil-

lates, and microcrystalline waxes from the residues.

The paraffin waxes can be subdivided into two categories: refined paraffin wax and refined, or white scale.

Refined paraffin wax is sold on a setting or melting point basis; so that the refining procedures have divided the total wax in the distillate into a series of fractions of varying melting point, it being the aim of the producer to manufacture the largest volume of the most profitable products. This gives the so-called "grades" of refined paraffin. A grade specifies certain setting point limits, and a wax of a given grade should melt between these limits when tested by a standard setting point or melting point test. The temperature ranges vary from 2 to 5 F, and the grades available on the market vary from occasionally 160 to 165 F paraffin wax, down to 95 to 100 F paraffin wax. A refined paraffin wax should be free from odour and taste, have a colour of 1·0Y or under when tested by the appropriate IP colour test, and show little reversion on storage, and have an oil content under 0·3 per cent. It should also show a reasonably sharp setting point and should not have an unduly wide setting point range of constituents.

A white scale, on the other hand, may have a somewhat more pronounced odour, a slightly higher colour (say from 2·0Y to 5Y), from about 1 to 2 per cent of oil, and a wider range of setting point constituents. In a sense, it is an incompletely refined paraffin wax, and sells at a lower price.

Microcrystalline Waxes

These vary in colour from almost black, through brown, to orange, yellow, or white. It is also sold on a s.p. basis, and the oil content can vary upward from under 1 per cent up to what the buyer is prepared to accept. They differ from paraffin waxes in that their structure is very much finer—hence the term microcrystalline. Although two microcrystalline waxes may have about the same setting point, the same oil content, and the same colour, one may be very hard and brittle, and the other plastic and pliable. These special properties are, however, highly valued by the user. This difference in hardness and pliability is because the first type is mainly composed of straight chain paraffins, and the second type is composed mainly of branched and cyclic paraffins. If confusion is to be avoided in the marketing of MX waxes, the setting point, approximate colour, oil content, and, say, penetration at one or more temperatures, should always be specified.

Packaging and Transport of Waxes

Refined paraffin waxes and white scales are usually slabbed into cakes, about 24 · 12 · 1½ inch, which weigh about 14 lb, in water-cooled cells. Occasionally the slabbing is carried out in pans of about the same dimensions, which are air cooled. White scales may be cooled in a film on water-cooled drums, and flaked off into a barrel. Microcrystalline waxes are slabbed, or packed in a variety of ways suitable to their special properties.

Slabbed wax is usually made up into 1 cwt lots and wrapped in a light cotton, or a paper covering, and the whole placed in a gunny or hessian sack, the mouth of which is sewn up.

Some points regarding the transportation of wax may be considered. It is a solid which softens rapidly with rise of temperature, e.g. a 125-130 grade, i.e. a wax melting somewhere around 128 F, may be more of a highly viscous fluid than a solid at temperatures around 110 F, and will start softening at temperatures of about 85 F.

Petroleum waxes are produced from refineries situated all over the world. If the waxes are produced in the temperate zones, the transportation problems are minimized, the main requirement being proper storage. Wax may

also be shipped liquid in heat-insulated cars, or slabbed in refrigerated cars, as is sometimes the case in the U.S.A. When the refinery is situated in tropical, or semi-tropical zones, control of the mechanical properties of the waxes, and careful attention to storage and shipping is essential.

Properties

Petroleum waxes differ from other petroleum products in that for nearly all utilizations they are valued on account of their physical and mechanical properties in the solid state.

These properties are determined by the chemical components of which they are comprised. All such waxes, when pure, are complex mixtures of paraffin hydrocarbons. Each setting point grade of paraffin wax has very much the same total range of constituents; that is to say from about 16 to 36 or so carbon atoms, but they vary in that there is a greater concentration of those constituents which melt around the mean setting point of the grade. The solid state properties of the grade arise due to the total, or integrated effect of all the paraffins composing it, but not in an altogether additive manner. Thus a pure normal paraffin, say one containing 26 carbon atoms, set. pt. 133·5°F, is a dazzling opaque white at room temperature and is crumbly, whilst a paraffin wax, melting at the same temperature, 133·5°F, is very much less crystalline and has some measure of translucency and is much tougher. The presence of low setting point paraffins confers softness and plasticity on the wax; and this is especially the case for branched or other cyclic paraffins. Freedom from low melting point paraffins, and from the branched and cyclic paraffins confers a slower rate of softening with rise of temperature. Also, presence of oil, even in quantities as low as 0·1 per cent, has a measurable effect in reducing tensile strength, rupture strength, and hardness. Over about 0·5 per cent of oil may confer a definite crumbliness on the wax.

There is another property of the normal paraffin, known as its solid state transition, which also affects the property of paraffin waxes. For a commercial wax the transition takes place over a temperature range, and is never entirely complete; and this is very roughly the difference between transition in a pure *n*-paraffin, and the transition that occurs in a commercial wax mixture.

Wax owes its translucency to the fact that many of its constituents are in motion, which also accounts partly for its plasticity and toughness. The change from the low temperature stable form to the high causes rapid softening, rapid changes in density, electrical properties, and so forth, all of which occur at temperatures of 20 to 40°F below the melting point of the wax. These various solid state properties can be controlled or modified, within restricted limits, by alterations to the wax cuts taken, and by suitable blending.

Utilization

The following table[1] divides the main uses into seven categories and gives the estimated percentage use for each.

TABLE III
MAIN USES OF PETROLEUM WAXES

Industry	Estimated percentage of total consumption used in industry	
	U.S.A.	U.K.
Packaging*	57	25
Candle	8	35
Polish	8	10
Electrical	2	10
Rubber	1	2
Leather	5	2
Match	5	2

*Includes application to paper, board, cartons, and foils.

Based on Thorpe's classification, the uses of wax are briefly as follows:

[1] Thorpe, *J. Inst. Petrol*, 1951 **37**, 275

Packaging

This in nearly all cases concerns foodstuffs. This includes the waxing of paper, either on one or both sides and the manufacture of laminated papers and foils. The latter consists of two sheets of paper, or a sheet of paper and foil, stuck together by a petroleum wax or petroleum wax mixture. They are used for waxed cartons or containers, e.g. for ices, milk, cream, or deep-freeze purposes, and for making waxed paper board or paper coated board. Such waxing may be carried out by passing the paper through a waxing bath, and cooling the coated paper, usually by shock chilling since that produces the best gloss. In the case of cartons and containers the waxing is usually by dipping in a wax bath, or spraying with molten wax. The paper or board may also be waxed during manufacture by incorporating the wax, in the form of an aqueous emulsion, in the pulp during the heater stage.

In many cases, also, after packing the article with a waxed wrapping, the edges of the paper require to be wax sealed. This is usually done by passing the edges over a heated metal surface, which melts the wax on the paper. On cooling the wax solidifies again and produces an airtight seal.

Thorpe evaluates the desirable qualities of the waxes for packages for foodstuffs roughly in the following order:
(1) *Freedom from odour and taste.*
(2) *Flexibility of the film of wax or waxed article.* The importance of this is obvious, since any cracking of the waxed film will destroy or limit the prime purpose of the packaging. This requirement brings to the fore the importance of mechanical testing of waxes.
(3) *Waterproofness.* This is the property of preventing water leaking either out of, or into, the packed material, or its packaging. It depends partly on the wax possessing the property of forming and maintaining a continuous film, and partly on the quality of the waxing.
(4) *Low viscosity of the wax in the liquid state.* This makes for economical use.
(5) *Grease and oil resistance.*
(6) *Moisture-vapour resistance.* This is the capacity of the waxed packages to resist ingress or egress of moisture, or other vapour contained in the atmosphere.

Thorpe lists many other properties he considers to be of less importance.

Candle Manufacture and Matches

In this group the prime requirement is that the wax shall burn with a clear white flame and be free from smoking. Since all waxes behave in this manner unless they contain excessive quantities of oil, no difficulty arises. The group includes candles, nightlights, tapers, match sticks, and match heads.

The demand on the wax is much less stringent here; and white scales are frequently employed. Candle manufacture requires that the candle shall be readily ejected from the mould; which feature, where high ambient temperatures occur, is assured by the manufacturer with the inclusion of suitable ingredients in his formula—usually mineral or vegetable oil; that the candle should be of fine structure and opaque, which property is also assured by the inclusion of a small amount of special waxes which confer microcrystallinity; and that the candle should not bend and distort under high ambient temperature conditions. This is partly assured by the wax mixture made up by the manufacturer, and partly by the selection of a paraffin wax which does not soften too rapidly with rise of temperature.

For match manufacture, relatively low setting point wax scales are usually employed.

Polishes

Petroleum waxes are employed in nearly all polishes which are supplied as

pastes, liquids, or emulsions, and which usually contain besides petroleum waxes and the vehicle, waxes of vegetable or animal origin, two of the most important being carnauba wax (a vegetable wax from a Brazilian pine) and beeswax. There are, however, literally thousands of formulae. The requirements are that a polish must spread evenly and easily when applied to the surface; polish with the minimum effort to a continuous, impervious, and highly glossy finish; be resistant to smearing; store well, i.e. a paste polish must not lose solvent (usually of the white spirit type) thereby giving a cracked and hardened material; and look nice, smell nice, and preserve the material on which it is applied.

A paste shoe polish may be a mixture of carnauba wax, paraffin wax, microcrystalline wax, and white spirit. The carnauba wax gives a polish of good gloss and freedom from smear; the paraffin wax aids in the easy spreading of the polishes and acts as an extender; and the microcrystalline wax helps, with the carnauba wax, to render the mix finely textured, without being too hard, and thus prevents rapid evaporation of the solvent which occurs with mixes that are too crystalline. Usually a high melting point paraffin wax is preferred, and a microcrystalline wax, reasonably free from oil, that is midway in properties between the very hard and very soft micro waxes.

The demands on the paraffin wax are not stringent, but the demands on the micro wax are, for it is this ingredient that ensures good solvent retention characteristics.

Electrical Uses

Petroleum waxes are employed in the electrical industry mainly for insulation purposes, for petroleum waxes are among the best insulators known; their limitation is, however, that they soften or liquefy when heated, and a great many electrical appliances heat in use.

Insulating waxes are used as a coating for wires, cables, or flat and irregular surfaces; as an impregnant of another material, such as paper, wood, cloth, or asbestos to increase its insulation properties; or as a sealing medium.

The fundamental requirements are good ductility, low shrinkage, and good insulation.

Most insulating waxes are compounded either by the electrical industry, or by a supplier specializing in the process. Few are pure petroleum waxes. The demands on the waxes do not appear to be stringent, but freedom from water and acidity are a first requirement. Microcrystalline waxes are preferred, as they are more ductile at all temperatures, and on account of their melting point, can be used over a larger temperature range.

Rubber

Petroleum waxes usually in small amounts are added to the mixes prepared from natural rubber as "softeners" during processing. In the finished product the wax has the interesting property of working to the surface, causing a "bloom" which protects the article from sun cracking. This bloom may also act as a lubricant for moving surfaces.

Miscellaneous Uses

Petroleum waxes are also used in the leather industry for preservation and dressing, as a constituent of pharmaceuticals, such as ointments, and in cosmetics. They are used in explosives, including cartridge cases, and in fireworks. They are used for coating cheeses and fruits, especially apples and citrus fruits. They are used as an ingredient in crayons and waxed pencils, and in carbon papers. They find employment in dental waxes and in beauty parlours (as wax baths). They are an ingredient of modelling composition including precision casting. They are an ingredient of gramophone and dictaphone records. They are used for

waterproofing textiles, and have been used with great success in the process of removing the feathers from poultry.

They are also being found of increasing use as a raw material for chemical products, e.g. chlorinated paraffins, and numerous other uses.

Petroleum waxes are therefore used in an enormous variety of ways; as Thorpe rightly states "they can claim to be the most versatile product in the oil industry".

Trends in Manufacture

The history of the development of petroleum waxes in industry does not present a clear pattern of planned progress. Originally paraffin wax was used for candle manufacture, and the early development of the shale oil industry was for that purpose. As petroleum products increased in number, and more and more wax was available as more and more mineral lubricants were required, surplus wax was available as a relatively cheap product in a relatively pure state; and more and more uses were found. Initially, waxes as separated from petroleum fraction were employed; but it was found that some waxes were more suitable than others, and as they became available, were bought in preference to less suitable waxes. In this way investigation was stimulated, so that the petroleum refineries could manufacture waxes to meet increasingly more stringent demands; demands of special melting point; of freedom from taste and odour; for colourless products that remain colourless; for low oil content; of differing degrees of plasticity and hardness; of a fine crystalline structure. All these qualities and others are demanded by a host of industries, and can be met to a greater or lesser extent, either by introducing modifications to the wax processes and/or refining; or by admixture of the petroleum waxes with other waxes, or materials from other sources. In this respect, petroleum waxes do not differ from the general pattern of economic exploitation of all crude oil products.

Miscellaneous Uses

The diversity of uses to which petroleum waxes are put means that a shipment of refined wax when dispersed to all customers may be used for candles, for packaging purposes, for polishes, for electrical insulation, for dressing leather, for making crayons, carbon paper, cosmetics, ointments, fireworks, matches, and so on. Generally, the same wax may have to do for most of these purposes, or it may be sold to a merchant or blended to make up special compounds for special purposes.

Testing

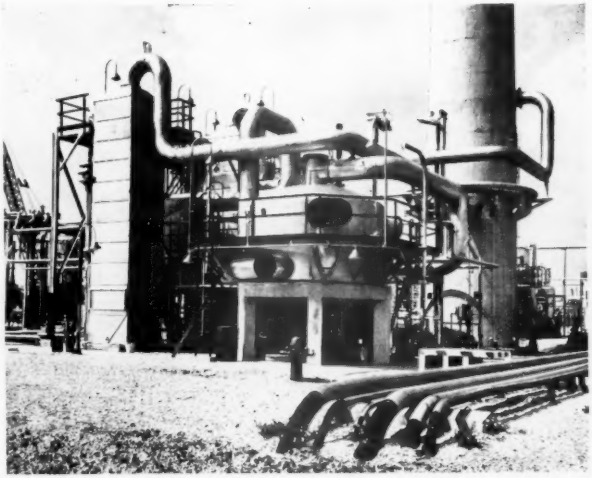
Clearly it would be impossible to institute tests to cover anything like all these uses, so the producer confines himself to tests of general utility; such as setting point odour, taste, colour, oil content, and probably one or more mechanical tests, such as penetration, hardness, rupture, or tensile strength. Naturally specialized tests, such as the moisture permeability of a waxed paper, may also be made, as well as those for such properties as self-sealing, flexibility, and the solvent retention of wax pastes. Once, however, the producer starts on such investigations, he runs into trouble because in such specialized tests, the results obtained often depend just as much, if not more, on the other materials used, such as for example, the paper, in the packaging industry.

Special Tests

Here again, the successful utilization of petroleum waxes is conforming to the general pattern, for special utilizations demand special tests which are best devised by collaboration between producers and users, and this is the present trend in devising special tests for petroleum waxes.

SULPHUR RECOVERY AT FAWLEY

Sulphur occurs in considerable quantities in Middle East crude, not as elemental sulphur but combined in the crude oil. These sulphur compounds appear in all petroleum products obtained from Middle East crude in varying degrees of concentration. During the process of catalytic cracking, an appreciable quantity of the sulphur compounds are converted to hydrogen sulphide gas (H_2S) which appears in the light ends fraction. This H_2S is recovered relatively easily from the light ends and can be used to make elemental sulphur.



The sulphur recovery plant at the Esso refinery, Fawley, which produces 40 tons of 99·5 per cent pure sulphur daily from hydrogen sulphide gas generated in the fluid catalytic cracking process.

Production from Hydrogen Sulphide Gas

The process of converting hydrogen sulphide to sulphur consists essentially of burning the H_2S gas with air under controlled conditions and by reaction over a catalyst. The sulphur is produced in liquid form and if this is kept at the correct temperature it can be pumped through pipelines like any other liquid. Solid or rock sulphur can then be produced from this liquid sulphur by cooling in the air.

The Fawley Process

The Fawley sulphur plant which is now in operation is producing 40 tons of sulphur of a purity of over 99½ per cent per day. It is produced mainly from the H_2S recovered from the lighter products of the catalytic cracking process from which the H_2S is removed by washing with diethanolamine solution (DEA) without affecting the remainder of the product. The DEA solution, after boiling to liberate almost pure H_2S gas, is used again to wash more feed.

The H_2S produced is burned with a controlled amount of air and the sulphur produced is removed from the unconverted gas by scrubbing with a liquid sulphur. The unconverted gas is heated over a catalyst and produces more sulphur. The sulphur in liquid form is pumped to open tanks where it cools and solidifies. The rock sulphur thus produced is broken up, loaded, and shipped in rail cars.

It is estimated that dollar imports of sulphur (at the 1952 rate) could be cut by 4 per cent as the result of the sulphur recovery at Fawley.

PERSONAL NOTES

Dr Gustav Egloff, F.Inst.Pet., director of research for Universal Oil Products Company, has been elected an honorary fellow of the Royal Society of Edinburgh. Dr. Egloff joins an imposing list of world-famous men who are honorary fellows of the Royal Society, which was instituted by Royal Charter in 1783 for the promotion of science and literature.

R. F. Baldwin, F.Inst. Pet., has been appointed general manager of W. B. Dick & Co. Ltd.

G. W. Nokes, A.M.Inst.Pet., has been appointed general manager of Peabody Ltd., the combustion engineers.

H. Norman G. Allen has been re-elected chairman of the British Internal Combustion Engine Research Association council for the current year.

Roger M. Serre has been appointed assistant to the vice-president of the Lummus Company's foreign sales operations, and **Virgil D. Drummond** has been engaged as assistant to the vice-president in connexion with sales engineering work.

Dr Ernest W. Dean, F.Inst.Pet., consulting chemist on the general administrative staff of the Standard Oil Development Company Ltd., has retired after more than 31 year's service with the Company. Dr Dean was formerly head of the petroleum laboratory at the Pittsburgh Experimental Station of the United States Bureau of Mines. He relinquished that post in order to become a director of the Standard Oil Development Co. Ltd., in 1922. In 1950, Dr Dean was appointed vice-chairman of the Products Committee, a position he held until his retirement.

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IRAQ OIL IN 1952

The year 1952 was an important one for Iraq and its oil industry, for it was in that year that the Basrah field of the Basrah Petroleum Company was inaugurated and added two million tons to the country's crude oil production, and the new 30-inch pipeline from Kirkuk to Banias enabled the production from the Kirkuk field to rise to over 15 million tons. Also, the Ain Zalah field of the Mosul Petroleum Company commenced production and was connected by a 12-inch pipeline and the main line to the Mediterranean.

The result of these developments was that production of crude oil by the Iraq Petroleum Company and its associated companies reached a total of 18·1 million tons in 1952 compared with 8·1 million tons in 1951.

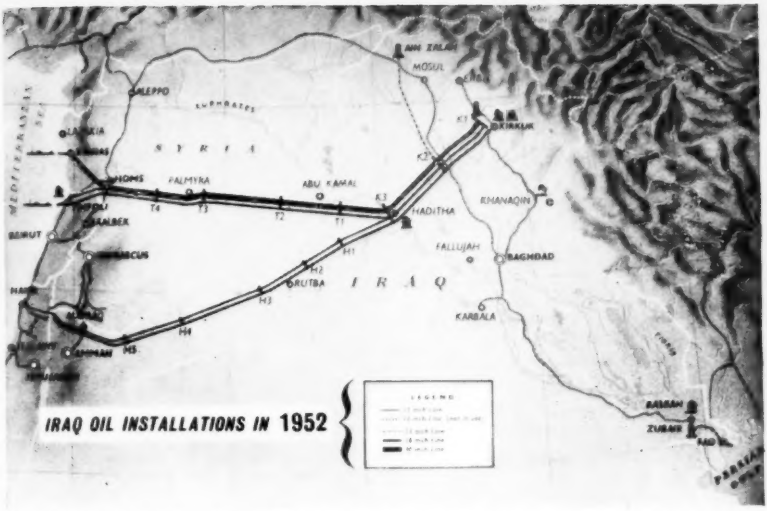
These vast developments are described and illustrated in "Iraq Oil in 1952" published by the Iraq Petroleum Company and dedicated in a foreword by the managing director, H. S. Gibson, C.B.E., to "the personnel whose efforts have contributed to the prosperity of this historic land."

Total production of the three fields is given as:

Kirkuk . . .	15,552,715 tons
Basrah	2,353,146 tons
Ain Zalah . . .	281,977 tons
TOTAL	18,187,838 tons

Kirkuk

All 1952 production was from the Baba dome, and this necessitated modifications to the four degassing stations. To maintain the December



Map of Iraq showing the oil installations and pipelines which had been completed by 31 December 1952.

1952 rate of production, which was equivalent to 20 million tons per annum, production will be spread over the Avanah and Baba domes and for this two new degassing stations have been installed at Sarabu and Sarbashakh.

The Kirkuk process plant stabilized 4198 million gallons of crude oil during 1952 and produced for internal distribution:

Benzine	3,080,000 gallons
Kerosine	2,680,000 gallons
Gas oil	3,430,000 gallons
Fuel oil	29,600,000 gallons

In addition 6,083,000 gallons of kerosine and 400,000 gallons of gas oil were produced and delivered for Iraq consumption at K.3 station.

A deep test well in the Kirkuk field had reached 10,523 feet at the end of the year. At Chemchemal a test well was suspended at 6116 feet without finding oil and the one at Khor Mor was drilling at 3353 feet at the end of 1952. On the IPC concession 16,676 feet were drilled in 1952, making a total of 388,808 feet since commencement of operations.

Zubair

Five rigs were in operation in the new Zubair field, 109,203 feet were drilled, ten wells were completed, and six were in progress at the end of the year.

Average daily production rose from 1974 tons in January to 8150 tons in December. Practically the whole of the pipe for the new 24-inch pipeline from Zubair to Fao had been received from British manufacturers by 31 December.

Ain Zalah

Prior to the war, 93 wells had been drilled in the Mosul Petroleum Company's concession area but only at Ain Zalah was a light oil discovered at 5100 feet. Since the war 14 wells have been drilled in this area and test wells at Mushorah and Butmah.

A 12-inch pipeline 135 miles long to K.2 pumping station was completed in September 1952 and put into operation.

CHEMICAL ENGINEERING

Part III — Furnaces

By D. C. FRESHWATER

So far this series has dealt only with those types of heat exchangers in which heat transferred by radiation is negligible compared with that transferred by the mechanisms of conduction and convection. It is now necessary to consider furnaces, in which heat transfer by radiation plays a major part.

By far the most important examples, in fact they form the primary units, in the petroleum refinery are the direct-fired tubular furnaces which are used in atmospheric and vacuum distillation, thermal cracking, and modern high temperature gas processing.

Such furnaces are required to handle fluids at temperatures up to 350 C or, where cracking is to take place, as high as 500 C.

Before pipe stills were developed crude oil was vaporized in pot stills. These stills were simply cylindrical steel vessels of up to 10,000-gal working capacity, mounted in a brick setting, and heated by direct firing beneath the still vessel. Today such equipment may be seen in operation in the coal tar industry but it has been almost completely displaced in the petroleum industry by the pipe still. The chief disadvantages of the pot or cylindrical still are as follows:

(*a*) The still contains a large quantity of petroleum whose exposure to the still temperature is prolonged, thereby giving rise to decomposition.

(*b*) The large quantity presents an additional fire risk compared with the pipe still.

(*c*) The efficiency of heat transfer is relatively low and is mainly by convection, whereas the pipe still is largely heated by radiation, as described later.

The Pipe Still

A pipe still for throughputs of the order of 100,000 g.p.d. may have a liquid capacity of only 2000 gal. The principal reason for the development of the pipe still was the need for equipment to handle large throughputs continuously and with high rates of heat transfer. In the pipe still this is achieved in two ways: firstly, by exposing a large area of heating surface to the fire—since the oil is contained in a large number of small tubes instead of one large cylinder; and, secondly, by decreasing the film resistance on the oil side with the oil flowing under turbulent conditions.

Heat transferred by radiation is proportional to the fourth power of the temperature difference. With hot oil at about 350 C and a flame at say 1800 C, the rate of heat transfer would be extremely high were it not for the resistance of the oil film inside the tubes. If this oil film is allowed to become appreciably thick the temperature gradient across it will be such that, whilst the main body of the oil is at a "safe" temperature, the oil at the metal surface will be so hot as to start decomposing or cracking. This is generally undesirable and with some types of charging stock may lead to deposition of carbon on the walls of the tube. In practice, high velocities through the tubes of the still are used so as to get a high efficiency of heat transfer, and in general, this has the secondary effect of preventing overheating.

Methods of Supplying Heat

Heat is supplied by the combustion of an oil fuel inside the furnace. Clearly there must be means for supplying the fuel, equipment for burning it efficiently, provision for admitting the air required for combustion, adequate space for combustion to be completed, and means for removing the waste gases as they are produced. These five requirements together with the heat receiving section

(in this case the oil inside the tubes of the pipe still) comprise the essential features of a furnace and are considered separately.

Supply of Oil Fuel

A steady supply of fuel to the burners is essential, as most furnaces are very sensitive to fluctuations in fuel rate. A number of burners are usually fed from the same source, and if they are connected in series then an alteration of the rate to one affects the rate of supply to all the others. This is overcome by circulating the oil through a ring main at two to three times the maximum rate at which it will be used. The burners are tapped off the ring main as required, but as

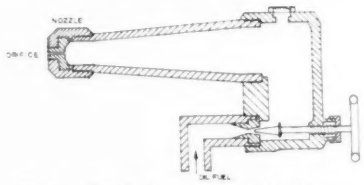


Fig 1a. Simple pressure atomizing burner.

each takes only a fraction of the total flow, the shutting or opening of one burner valve will have a negligible effect on the pressure in the main. Often the fuel used is highly viscous at normal temperatures and must be heated in order to make it flow easily from the supply tank to the burners. It is not uncommon for the lines through which the oil flows to be heated. This is accomplished by steam jackets on the pipes or by electrical heating with special resistance wire.

Burners

The burner fulfils two functions: first, to subdivide the oil stream into a number of small droplets so as to present a large surface area for rapid ignition and combustion; and, second, to introduce and admit air with the fine spray of oil so that the rapid combustion desired will not be retarded through lack of oxygen.

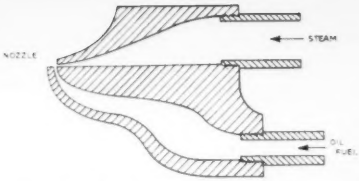


Fig. 1b. Simple steam atomizing burner.

The break up of the oil into a spray or "atomization," as it is termed, is usually brought about by forcing it through a nozzle at a high velocity with a jet of steam. In some cases, however, the pressure of the liquid fuel provides sufficient energy to bring about atomization. The mechanism of this need not be considered here but it may be noted that in an average installation the steam required may amount to 300 to 400 lb/hr per burner and the heat required to generate this steam must be added to the total heat input when calculating the thermal efficiency of a furnace.

The air is drawn into the spray by the entrainment action of the jet leaving the nozzle after the manner of the ejector described in the section on fluid flow. Admixture is assisted by spiral grooves cut into the inside of the nozzle which impart a swirling motion to the spray. Occasionally, corrosive fuels such as acid sludge are burnt and then the atomizing agent used is air. Fig. 1 shows three types of furnace burners which are in common use.

There is a tendency at the present time to replace liquid fuels by gaseous ones. Generally the gaseous fuel is more expensive (unless a cracking plant is in use; in which case combustible gases may

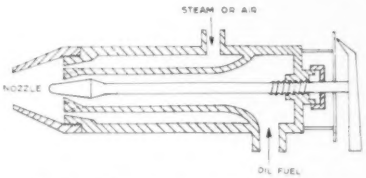


Fig. 1c. Steam or air atomizing burner.

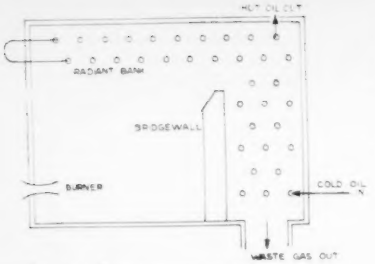


Fig. 2a. Down convection box-type heater.

be a waste product) but this is offset by the much greater ease of burning and control which results. Gas burning systems are simpler in that the gas does not require atomization or heating, and as the gas is generally clean and of steady composition, automatic control may easily be applied.

Combustion Space

When arranging a large number of tubes to "see the flame," as is done in the radiation section of a pipe still, a structure with a large combustion space is automatically incorporated. The various tube stills in Fig. 2 show this arrangement. If the combustion chamber is too small, undesirable effects, such as the direct impingement of flame on the tubes or furnace walls, will occur. The desired volume may be estimated by various empirical rules based on practical experience which lay down the maximum allowable heat release in B.T.U/hr/ft^3 of chamber volume. Common values are of the order of 2000 to 3000 B.T.U/hr/ft^3.

Removal of Waste Gases

The waste gases normally leave by a chimney which, because it encloses a column of hot gas appreciably lighter than an equivalent height of air at atmospheric temperature, provides a suction which draws the waste gases out of the furnace and also draws air into the furnace for combustion. The driving force or suction provided depends on the height of the chimney and the temperature of the flue gas inside it and formulae for calculating this are given in most standard texts on combustion engineering.

Common operating figures for the suction or draught in furnaces of pipe stills are:

above the bridge wall . 0·1 inch H_2O
exit of furnace . . . 0·25 inch H_2O

Some pipe stills are designed with the convection tubes spaced very closely together and others have air preheaters fitted in the waste gas flues. All such measures increase the resistance to flow

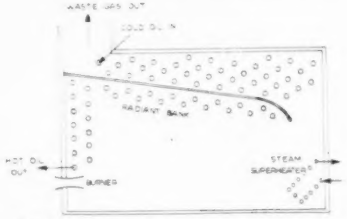


Fig. 2b. Overhead convection-type heater.

of the flue gas and in such cases it is often necessary to supplement the effect of the chimney by using a fan between the furnace exit and the stack. When a fan is used it is also possible to recirculate some of the flue gas into the combustion chamber with the object of giving a lower flame temperature, and hence a milder radiation rate, and also increasing the gas velocity and hence the heat transfer rate in the convection section.

Combustion Air

The air drawn in and admixed with the fuel is sufficient only for preliminary ignition of the fuel. As all the fuel cannot burn instantaneously some of the liquid becomes heated before combustion to such an extent that it vaporizes and leaves the zone of spray in which the ignition or primary air is confined. Moreover combustion is incomplete in this primary zone and gases, such as carbon monoxide and hydrogen, leave it. Additional air,

known as secondary air, must be supplied to burn such combustible vapours and gases as are produced; and hence burners commonly have two air controls—one for admission of primary air near the centre of the burner and one to admit air outside the zone of combustion. This secondary air must mix with the vapour, but the rate of travel of the gases through the furnace is such that were only the theoretical amount of air supplied combustion would be incomplete because mixing requires an appreciable time.

Hence it is necessary to supply more air than that indicated as necessary by combustion equations, this amount being known as excess air. Furnaces usually operate at about 30 to 40 per cent excess air. For any given fuel composition, the excess air is directly related to the CO_2 content of the flue gases. The CO_2 content is very easy to measure and hence this relationship is a simple way of determining the efficiency of combustion during operation.

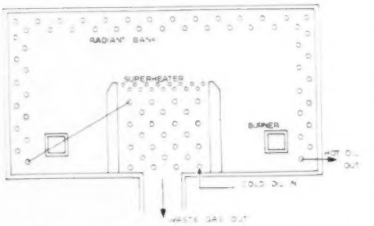


Fig. 2c. Large-duty centre convection-type heater.

General Notes on the Construction and Operation of Tube Stills

Fig. 2 shows in diagrammatic form the layout of four types of tube stills. In the standard type of construction, the tubes are carried in metal tube plates which must be loose fitting so as to allow for expansion. The tube plates are fixed to a framework of steel joists and the furnace walls built up around this framework. The walls are built of refractory material capable of withstanding the high temperatures obtained inside the furnace. To protect the refractory bricks and to reduce heat loss, a second thickness of ordinary brick is built on the outside with perhaps an intermediate layer of insulating brick. The furnace roof, one of the most difficult parts of the unit to construct, is built up of specially shaped interlocking refractory bricks, which are suspended from a number of tie rods held by steel beams supported across the framework.

There is no rigid connexion between the roof and walls, since expansion caused by heating and cooling the structure would subject a rigid structure to excessive stresses. The same is true of the bridge wall which in most types of furnaces separates the combustion chamber from the convection section. The tubes project far enough out from the tube plates to enable return bends to be fitted between adjacent pairs of tubes, thus connecting them all in series. These return bends are of special design enabling the tubes to be cleaned out *in situ* after a shut-down (Fig. 3). The floor of the furnace is either above ground completely or constructed with a number of small air channels below it, so that there is a certain amount of air cooling to reduce the working temperature of the floor and so prolong its life.

In starting up a tube still the furnace must be brought up to temperature slowly, a warming up period of thirty-six hours not being uncommon, otherwise the refractory materials may disintegrate, if heated rapidly, due to differential expansion. As the furnace is warmed up, so the crude oil is circulated through the tubes; and as its temperature rises it

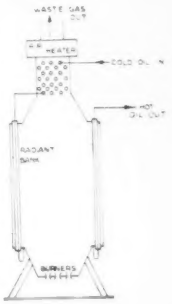


Fig. 2d. De Florez-type upshot heater.

begins to vaporize, and so gradually the warming up period passes into normal operation. With most crude oils, a certain amount of thermal decomposition occurs in the still, with the deposition of coke on the inside of the tubes. This necessitates periodic shut downs, in order to clean out the tubes, at intervals which may be measured in months or longer periods depending on the nature of the material being handled. Carbon is also deposited on the outside of the tubes, particularly in the cooler parts of the furnace, in the form of soot. If allowed to remain and build up this soot would seriously affect the heat transfer rate and also increase the pressure drop through the furnace. Thus provision is made for the removal of the soot. This is done by directing a jet of high pressure steam or compressed air on to the outside of the tubes.

Equipment for carrying out this soot-blowing, as it is called, is usually built into the furnace and may be operated externally whilst the unit is working. If a tube inside the furnace fails due to local over-heating or corrosion, hot oil will pour into the combustion chamber and ignite. Such occasional tube ruptures are rarely serious because provision is made for admitting large quantities of steam into the combustion chamber which, by excluding oxygen from the space, prevents combustion from persisting. Moreover as mentioned earlier, the total liquid capacity of the pipe still is relatively small and hence such fires are quickly localized.

A common feature of most pipe stills

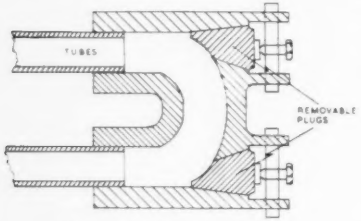


Fig. 3. Tube still return bend.

is the provision of steam superheater tubes in the furnace to superheat the steam used for stripping volatile material out of heavy bottoms in the fractionating column attached to the still. Superheaters are generally placed in the path of the hot gases between the end of the radiant section and the beginning of the convection section.

Considering now the operation of the furnaces, that shown in Fig. 2a is one of the oldest and most widely used types of construction, sometimes known as the box-type furnace on account of its rectangular shape. The oil enters the bottom of the convection bank which is at the lowest temperature and passes through successive rows of tubes, being heated on its way up by the hot gases passing downwards over the tubes. It then enters the radiant section tubes, passing through each tube in series, and finally leaves the furnace after being heated by radiation from the flame, to the requisite temperature. Furnaces of this type may have a capacity of from 25,000,000 to 100,000,000 B.T.U/hr heat input to the oil of which about 55 per cent is absorbed in the radiant section and 45 per cent in the convection section.

These furnaces are usually cheap to construct but suffer from the disadvantages of a tendency for the radiant bank tubes above the bridge wall to become overheated and the difficulty of providing a large percentage of radiant absorption surface unless a very long and hence expensive combustion chamber is built.

The overhead convection-type heater (Fig. 2b) was developed particularly for small duties. The bridge wall is replaced by a metal partition plate, overlaid with insulating material which rests on the tubes; and the convection tubes are then directly above the radiant tubes. Distribution of radiant heat is said to be poor in this type of furnace.

The centre convection-type heater (Fig. 2c) resembles two box-type furnaces placed together, end to end. Note that practically all the wall area of the

combustion chamber is covered with tubes which results, with this type of unit, in the provision of sufficient radiant surface to absorb 65 per cent of the total heat liberation. This construction is also well suited to the modern tendency to use a number of small burners evenly spaced round the furnace rather than two or three large ones.

The De Florez upshot heater (Fig. 2d) is circular in cross-section and employs vertical tubes in the radiant bank. All such tubes are equidistant from the burners, thus ensuring good heat distribution. The furnace is fired from the bottom and has so little convection surface that an air preheater is added; thereby reducing the temperature of the waste gases and improving the thermal efficiency. Such units are expensive and require a tall superstructure to allow the tubes to be removed. However the vertical position of the furnace makes it act partly as a stack and thus reduces the height of chimney required. It finds particular application as a cracking furnace.

For more detailed treatment the reader is referred to the following:

Petroleum Refinery Engineering, 3rd ed. Nelson, McGraw-Hill Publ. Co.

Process Heat Transfer, 1st ed. Kern, McGraw-Hill Publ. Co.

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JOHN ORIEL TRAVEL BURSARIES

Just founded by the Sir John Cass College are two bursaries, value about £20 each, awarded annually to assist students undertaking vacation abroad. The bursaries were established in acknowledgment to J. A. Oriel, C.B.E., M.C., M.A., for his work as chairman of the College Consultation Committee on Petroleum and preference is given to students intending to enter the petroleum industry.

HD OILS

The following oils have been approved by the Director of Chemical Inspection, Ministry of Supply, as complying with the requirements of defence specification DEF 2101, Grade OMD 110:

Suppliers' Nomenclature	*Supplier*
Shell Oil S.3642†	Shell Mex and B.P. Ltd. (now "Shell" Refining & Marketing Co. Ltd.).
Shell Oil S.3507*	Shell Company of Australia Ltd.
Shell Oil S.3164	ditto
Shell Oil S.3642†	ditto
Britalliance 30-2023†	British Alliance Oil Corp. Ltd.
Centos H.D. 30	Wm. Walker Ltd.
Brit-Gulf X-H.D. 30	Gulf Oil (Great Britain) Ltd.
Lobitos No. 1 Engine Oil	Lobitos Oilfields Ltd.
Morola H.D. 30	Marine and Industrial Lubs. Ltd.
B.P. Energol Diesel D	Anglo-Iranian Oil Co. Ltd.
B.P. Energol Diesel D Grade SAE 20*	ditto
Dragoafly Diesoline	R.D. Nicholl & Co. Ltd.
Laran H.D. 30	Fina Petroleum Products Ltd.
Chevron Tuscan H.D. 30	Berry Wiggins & Co. Ltd.
Chevron Tuscan H.D. 50†	ditto
Appenol MHD 30	J. English & Co. Ltd.
Appenol EHD 50†	ditto
Byvolube GL HD 30	Alfred Hopps, Sons & Co. Ltd.
Byvolube GL HD 50†	ditto
Omegal DM 50†	Liberty Oils Ltd.
Liberoyle DM 30	ditto
Vigzol RE 30	Vigzol Oil Co. Ltd.
Vigzol RE 50†	ditto
Wiggextra H.D. 30	Edward Wiggins & Co. Ltd.
Wiggextra H.D. 50†	ditto
Tiptone HD-30-MIL	Joseph Batson & Co. Ltd.
Ideal 30	Arthur Brown & Co. Ltd.
Wakefield D.F. 20*	C. C. Wakefield & Co. Ltd.
Wakefield D.F. 30	ditto
Wakefield D.F. 50†	ditto
Neptune Heavy Duty 20*	Neptune Oil Co. Proprietary Ltd.
Neptune Heavy Duty 30	ditto
Neptune Heavy Duty 50†	ditto
Rimer's XHD 30	Rimer Bros. Ltd.
Rimer's XHD 50†	ditto
Defiance BTT Oil 23	Goodall Bates & Todd Ltd.
Crosoll G.B. HD 30	Garth & Brown Ltd.
Crosoll G.B. HD 50†	ditto
Arnoco MHD 50†	James Arnott & Sons Ltd.
Arnoco MHD 30	ditto
Bartoline "ZYZ" HD 30	Bartoline (Hull) Ltd.
Bartoline "ZYZ" HD 50†	ditto
Primor Mil 30 H.D.A.	Manchester Oil Refinery Ltd.
Primor Mil-50-H.D.†	ditto
Liadgo LHD 30	James Light & Son Ltd.
Liadgo LHD-50†	ditto
Celerine MEDETER AMD 3	Liddiard Lubricants Ltd.
Celerine MEDETER AMD 5†	ditto
Thelson Diesel Engine Oil MDS 30	Kenneth Thelwall Ltd.

*Grade OMD 60
†Grade OMD 330

ADEN REFINERY PROGRESS

After eight months' preliminary work on Anglo-Iranian Oil Company's five million tons a year refinery being built at Aden, emphasis has swung from site and camp preparation to refinery erection. By mid-June the first eight towers and vessels for the sulphur dioxide extraction plant were in position, this being the first refinery plant erected. Over a million yards of sand had been dredged from the harbour; 335,000 yards of rock, one-third of the total required, had been placed in position in the permanent harbour works; and a 700-foot pontoon bridge had been laid across the Khor Bir Ahmed, a narrow strip of water between the refinery site and Aden town.

The pouring of foundations for major refinery plant began in June this year. In addition to the work on the sulphur dioxide units, concrete foundations are being poured for one of the two topping units, and the laying of underground piping has started. Excavation work for the foundations of other refinery plant is well advanced.

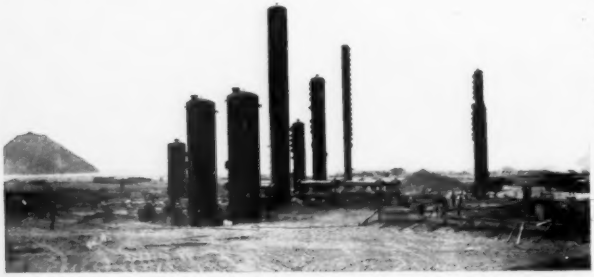
Equipment

When the refinery is completed at the end of 1954, in addition to the topping units, each with a capacity of 60,000 b.s.d., there will be a platformer with a capacity of 12,000 b.s.d., a sulphur dioxide extraction plant with a capacity of 8800 b.s.d., and an autofiner capable of handling 3500 b.s.d., as well as miscellaneous sweetening plants.

In the nine months from November 1952 to July 1953 nearly 80,000 tons of equipment and materials were delivered to Aden from the U.K., Europe, and the U.S.A. These shipments were for both the refinery and harbour projects and were off-loaded in Aden harbour on to barges for the trip across the bay to Little Aden, the site of the refinery. This terrific tonnage has created a great deal of extra stevedoring work but in no way has it disrupted the services of Aden port.

As equipment has been unloaded, men and machines have worked steadily at levelling the refinery site. Huge volcanic growths have been almost cleared, one large quarrying operation being on 6 July when a rocky feature between the refinery site and the port area, known as Wedge Hill, was blasted with 34 tons of explosive. Over 100,000 tons of rock were dislodged and large blocks will be used in the armouring of the breakwater being constructed to protect shipping against the storms of the monsoon season.

During the building of the refinery, which will cost between £40 million and £50 million, approximately 100,000 tons of steel will be used in the plant, storage tanks, and jetties. Over 20,000 tons of cement will be required to mix the 180,000 cubic yards of concrete which will go into the construction of the refinery and port.



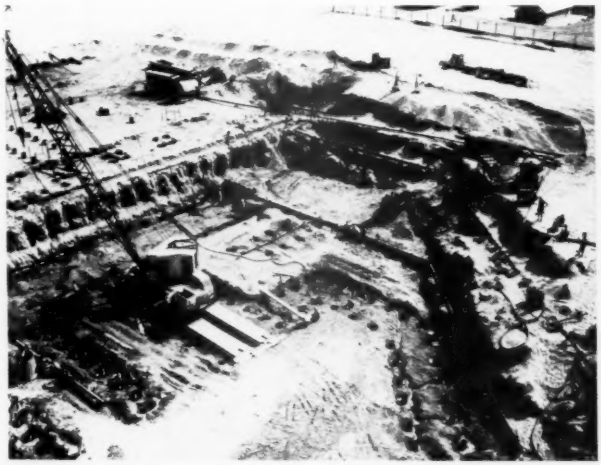
New growths in the desert. Towers of the SO_2 recovery plant, which has a capacity of 360,000 tons per year.

Foundation piles being driven for the four boiler stacks of the refinery power house.

Several million board feet of timber for concrete shuttering is being imported.

One of the first tasks on the site was the building of construction camps, each a temporary townlet complete with its own living quarters, mess, recreation centre, and other facilities. These camps are being expanded as the labour force grows. In addition to accommodation buildings, stores, workshops, a temporary hospital, and a garage were all erected and operating within four months of the start of work. More recently electrical, welding, carpentry, and plumbing shops, power plant, cold storage plant, laundry, bakery, rock crusher, concrete batching plant, and an administration building were completed.

To provide the 500,000 gallons of water needed daily for domestic purposes in the construction camps, a number of deep wells have been drilled at Bir Ahmed, about 10 miles from site. Electric pumps raise the water from a depth of 90 feet. After chlorination the water is piped through a 6-inch line to the refinery site where a treating plant and four storage tanks have been built. Later more wells will be drilled and a 12-inch pipeline will provide water at the rate of about two million gallons a day for domestic and process requirements in both the refinery and harbour areas.



Site of the salt water pump bay upon completion of the pile driving.

HYDRODESULPHURIZATION AT STANLOW

The first hydrodesulphurization plant in the world is now under construction at Stanlow oil refinery, Cheshire. In the hydrodesulphurization process, the feedstock trickles in liquid form over the bed of a catalyst (cobalt molybdena on alumina) in the presence of hydrogen under pressure. Reactor pressures are of the order of 300-750 p.s.i.g. and reactor temperatures 340-400°C according to the nature of the feedstock.

A sulphur reduction of 85-90 per cent is said to be effected with very little attack of cracked or highly aromatic components present in the feedstock.

Since the feedstock does not have to be vaporized, the new process results in considerable economies in the heat transfer equipment and fuel, as well as in hydrogen compressors, pipelines, and valves.

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WORLD OIL PRODUCTION IN 1953

Summarizing the world's crude oil production for the first six months of 1953, *Petroleum Press Service* says: "Production of crude oil in the free world in January-June 1953 reached a new high level output of about 290 million tons for the six months' period, which compares with 274 million metric tons in the corresponding period in 1952 and with 287 million tons in the second half of last year. A slight decrease in output in the Western Hemisphere, owing to seasonal factors, was more than offset by higher output in the Middle East. Production in the U.S.S.R. and Eastern Europe is also rising. The increase of about 5 per cent in production in the free world in the past half-year compared with the corresponding period of 1952 is in line with the long-term rate of progress which the oil industry enjoys."

Details of world crude oil estimated production are given as:

(Thousand Metric Tons)

	Jan.-June 1952	July-Dec. 1952	Jan.-June 1953
North America:			
U.S.A.: California	24,042	24,405	24,360
E. of California	125,932	134,599	133,840
	149,974	159,004	158,200
Canada	3,525	4,740	4,500
	153,499	163,744	162,700
Latin America:			
Caribbean Area			
Venezuela	47,971	46,655	46,000
Colombia	2,712	2,720	2,800
Trinidad	1,509	1,567	1,600
	52,192	50,942	50,400
Other Countries:			
Mexico	5,530	5,370	5,350
Argentina	1,796	1,774	1,800
Peru	1,077	1,099	1,100
Ecuador	184	200	210
Chile	52	64	67
Others (*a*)	87	90	90
	8,726	8,597	8,617
Middle East:			
Saudi Arabia	20,958	19,551	20,205
Kuwait	18,543	19,094	20,700
Iraq	7,571	11,272	13,510
Qatar	1,534	1,763	1,947
Egypt	1,180	1,170	1,200
Bahrein	750	760	750
Persia	741	607	600
Turkey	10	12	14
	51,287	54,229	58,916
Far East:			
Indonesia	3,981	4,543	4,500
Br. Borneo	2,574	2,576	2,300
Japan	154	156	150
India	125	125	125
W. New Guinea	120	120	120
Pakistan	87	92	118
Burma	55	55	60
	7,096	7,667	7,373
European Area:			
Germany	822	933	1,024
Netherlands	363	352	360
France	170	180	180
Morocco Algeria	66	81	85
Yugoslavia	72	80	80
Italy	22	41	45
U.K.	27	28	28
	1,542	1,695	1,802
FREE WORLD	**274,342**	**286,874**	**289,808**
Eastern Europe and China:			
U.S.S.R.	23,100	24,400	25,700
Rumania (*b*)	2,000	2,000	2,000
Austria	1,300	1,500	1,600
Hungary	250	250	250
Poland	115	120	125
Albania	100	100	100
Czechoslovakia	45	65	90
China	70	80	100
	26,980	28,515	29,965
WORLD TOTAL	**301,222**	**315,389**	**319,773**

(*a*) Brazil, Bolivia and Cuba; (*b*) est. official statements appear to claim a higher level of production.

VACUUMS NEW TERMINAL

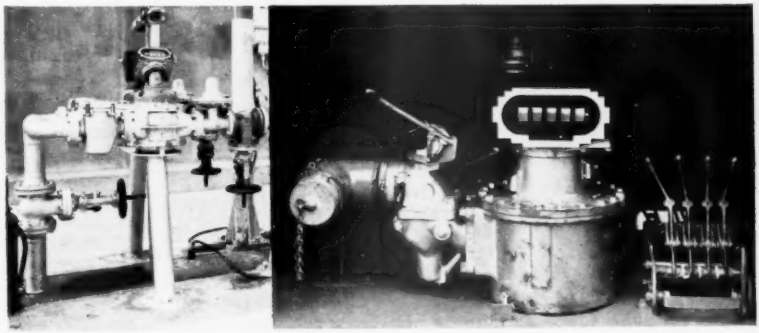
General view of the loading area covered by the steel and glass canopy. 2400-gallon road tank wagons are being filled—the operators can be seen on top of each vehicle controlling the operation.

A unique feature of Vacuum Oil Company's new bulk terminal at Wandsworth, London, is that the filling bays, which can accommodate eight large road tankers at once, are on top of a 650,000-gallon underground storage tank. This tank is 100 × 110 · 12 feet in size and is divided into four 120,000-gallon and two 85,000-gallon compartments. It stands on a 3-foot concrete base, is surrounded by 6 feet of concrete, and is covered by 1 foot of concrete, 2 feet of hardcore, and 1 foot of reinforced concrete.

Filling Procedure

Road tankers can be filled at the rate of 250 gallons per minute and by means of an automatic device, developed by the company's engineers, the filling procedure can be controlled by a single operator on top of the vehicle. The gasoline is metered into the vehicle through a Wayne flowmeter and when delivered to the customer is also metered from the tanker.

The terminal is fed from the Coryton refinery by river barges of 75,000-gallon capacity.



(left) The filling flow meter, visible to the operator on the tank wagon, and (right) the Wayne meter through which deliveries are made from the tank wagon. An accuracy of 0·01 per cent is claimed.

REVIEWS OF PETROLEUM TECHNOLOGY 1951

This thirteenth volume in the series of annual reviews on the progress of petroleum technology covers developments during 1951 and follows in general the lines of its predecessors. Throughout its twenty-one chapters there are nearly 3000 references to articles which appeared in the technical press during the period under review, which in some cases covers more than one year.

Three chapters cover 1950-51 (Plant instrumentation, Insulating and hydraulic oils, Bitumen), one (Petroleum waxes) 1949-51, and another (Transport, storage, and distribution) 1947-51. In his Preface, the Honorary Editor (Professor F. H. Garner, O.B.E.) makes special reference to this, and indicates that the future of "Reviews of Petroleum Technology" has been the subject of consideration by the Council of the Institute.

Since that preface was written, a decision has been taken to publish the reviews on a somewhat different and broader basis to cover a three-year period, and it is planned to issue the next volume early in 1955 to cover the triennial period 1952-54.

Copies are obtainable from the offices of the Institute, the price being £2 to members and £2 10s. to non-members.

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LONDON BRANCH BUFFET DANCE

Following the success of the London Branch's Buffet Dances in previous years a similar function has been included in the 1953-54 programme, to take place on Friday, 13 November, at the Paviour's Arms, Page Street, Westminster, S.W.1. The change of venue is due to the difficulty experienced in obtaining an extension of the bar licence at Manson House. At the Paviour's Arms the bar, it is anticipated, will be open until midnight, thus offering ample opportunities for relief to those dancers whose capers give rise to a great thirst.

The Paviour's Arms is well known for the success of the functions held there and members can be sure of a very enjoyable evening. Parking facilities are available close by for those who will travel by car.

The Chairman and Committee look forward to meeting members and their friends at the dance and hope that as many as possible will attend. Please make a note of the date now. Tickets, price 10/6 each, may be obtained from any member of the Committee or from the General Secretary of the Institute.

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BIMCAM HANDBOOK

The British Industrial Measuring and Control Apparatus Manufacturers' Association has just issued its first handbook. This contains details of the twenty-seven firms which make up BIMCAM with descriptions and illustrations of their manufactures, which cover a complete range of instruments for industry. The presidents of various technical bodies have contributed brief messages and H. S. Gibson, president of the IP, indicates the extent to which instruments and control equipment are used in the petroleum industry.

The Handbook is available from the Association at 21 Tothill Street, London, S.W.1.

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Shell-Mex and B.P. Ltd. have issued their 64-page annual record of the leading motor and motor-cycle racing events during 1952. The booklet contains nearly 100 illustrations and there are sections on hill climbs, rallies, records and tests, trials and scrambles, and so on. Copies may be obtained free from any divisional office of the Company, or from Shell-Mex and B.P. Ltd., Shell-Mex House, Strand, London, W.C.2.

AROUND THE BRANCHES

FAWLEY, LONDON, NORTHERN, PERSIAN GULF, SCOTTISH, SOUTH EASTERN, SOUTH WALES, STANLOW, TRINIDAD

South Eastern Branch

The first meeting of the 1953-54 session was held at the King's Head Hotel, Rochester, on 1 September 1953. On this occasion Mr G. E. Fish, who is the personnel manager for Messrs Samuel Williams & Co., Ltd., of Dagenham, was the speaker and the subject chosen by him was "Aspects of Personnel Management."

Mr Fish commenced his talk by briefly tracing the history that has led up to the present labour-management relations and stated that after the industrial revolution of approximately 200 years ago, working conditions were extremely bad until the Quakers, who included some of the larger employers of labour at that time, began to realize that their employees were human beings, and as such were entitled to more consideration. Mr Fish stated that wars created a lot of devastation and unhappiness but at the same time a certain amount of good ensued, inasmuch that after the first world war the term "welfare" became prominent amongst employers of labour, and persons were appointed who were known as "Welfare Officers." This did a lot to iron out some of the difficulties that existed between labour and management but even then the situation was not entirely satisfactory. Mr Fish explained the position which the present-day personnel manager held in industry, and pointed out that the term "Personnel Manager" was rather a misnomer, as he was, in fact, managed by the employee on the one side and by the employer on the other. He went on to explain that he had to be without either religion or politics, above suspicion, and be able to carry out the policy of his principals which might be either written or, in smaller firms, understood.

In the U.K. there are approximately twenty-three and a half million people in civil employment and if this number is multiplied a hundredfold it will give some indication of the number of different problems that can arise between worker and employer. Moreover, the problems must be classified into matters of education, health, ability, and so on.

Mr Fish concluded by explaining some of the purposes of Joint Committees and he stated that there was the danger of these becoming communistic in aspect, inasmuch as they became law-making instead of law-keeping but that properly controlled they formed an excellent means of bringing together all parties.

The meeting ended with a lively discussion between Mr Fish and branch members, after which the chairman thanked the speaker for giving such an excellent talk and stated that he felt sure that the members had learned quite a lot about personnel management.

South Wales Branch

On 3 September, the first meeting of the 1953-54 session was held at Llandarcy when a very large audience attended to hear H. S. Gibson Esq., C.B.E., M.A., M.I.Mech.E., President of the Institute of Petroleum and Managing Director of the Iraq Petroleum Company, give a talk on the Discovery and Development of an Oilfield.

The Branch Chairman, Mr R. B. Southall, opened the meeting and expressed the appreciation of the Branch for the honour conferred on it by Mr Gibson in giving the first lecture of the season.

Mr Gibson took for his example the discovery and development of the Zubair Field. Until recent years South Iraq had not received much attention.

The flat terrain had none of the usual features, such as seepages or outcrops, which suggested the possibility of an oilfield. Early studies had not been profitable, but the post-war development with the use of the new geophysical tools, using gravity-metric and seismic studies, led to more promising results. Eventually a test well was drilled in the Zubair area in 1948. This produced good quality crude oil in the "third-pay" in sandstone at 10,773 ft.

The Zubair field is one of the deepest oil-producing reservoirs in the world, the wells being about four times as deep as those in the Kirkuk field.

Mr Gibson drew attention to the oil being found in sandstone as distinct from the Persian fields where it is located in limestone. He went on briefly to describe the use of the Schlumberger system in determining resistivity, self-potential, and porosity as guides for the discovery of the largest oil pools. Reference was made to the great problem involved in materials and labour. A target date had been set under the concession terms and this was met, despite the many difficulties, with seven months ahead of the dead line. A 12-inch pipeline had been laid to Fao on the Persian Gulf for the handling of 2½ million tons of crude per year which could be loaded over the jetties at 2000 tons/hour.

Emphasis was laid on the need for reducing time and costs entailed in the drilling programme. By careful planning and study, drilling time was reduced from 300 days to 100 days per well. A feature in this programme was the ingenious arrangements for jacking up and transporting the drilling rig complete from one site to another in half a day.

Mr Gibson illustrated his talk with a number of interesting slides, and subsequently answered a number of questions posed by the audience.

Mr C. Dalley proposed a vote of thanks for a delightful talk, which was acclaimed in a most hearty manner.

MARKING OF CONTAINERS OF HAZARDOUS CHEMICALS

The Association of British Chemical Manufacturers has published a booklet "Marking Containers", which outlines a system of warning labels for hazardous chemicals. The booklet warns handlers and users that some products need special care. It applies only to the U.K. and primarily to chemicals passing in quantities exceeding 6 pints for liquids and 8lb for solids, up to and including the time the container is opened, for use in the premises of the recipient.

Specimen wording is given for labels in a first list of over 200 chemicals; wording for products not yet included can be worked out from the general principles and standard phrases described in detail.

The information given on the label includes the name (or other description), warning word, nature of hazard, precautions required, and accident or first-aid action. The Chief Inspector of Factories has welcomed the scheme and recommends it for adoption as a code of practice by all chemical manufacturers.

Copies of the booklet may be obtained from the Association at 166 Piccadilly, London, W.1. Price 7s 6d net, post free, cash with order.

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New Platformer. The world's largest unit is now in operation at Shell's Houston Refinery, Texas, U.S.A. Production is confined at present to benzene and toluene —16 million gallons of benzene p.a. or 28 million gallons of toluene p.a.

D'Arcy Exploration Company is to drill a test oilwell in the Vittoria concession area of Sicily. The drilling rig will be capable of reaching a depth of between 8000 and 10,000 ft.

"New Horizons" is the title of an attractive brochure, which tells the story of the huge Dunkirk refinery, recently built by the Lummus Company, New York.

Brooks and Walker Ltd., engineers suppliers, announce that the new address of their head office is 47 Great Eastern Street, London, E.C.2

CHEMICAL PLANT AND ENGINEERING EXHIBITION

Chemical engineering was destined to play a vital part in the industrial future of Great Britain, said Sir Harold Hartley, F.R.S., in an address to a Chemical Engineering Conference in London in August. To meet growing competition from Germany, Japan, and the rising countries of Asia there were three urgent needs for Great Britain—more chemical engineers and more schools of chemical engineering, chemical engineering construction companies with resources more nearly equal to those across the Atlantic, and more financial support for chemical engineering research.

The conference, organized by the Chemical Engineering Group, was held during the Engineering, Marine, and Welding Exhibition and the Chemical Plant Exhibition, the latter being the first post-war exhibition of its kind.

At both exhibitions there was much of interest to the petroleum industry and many Member Companies of the IP had stands. Among the exhibitors were the following, a brief indication of their exhibit being given:

Chemical Plant Exhibition

W. J. Fraser & Co. Ltd. The Shell patent Turbogrid distillation tray and a colour film of the firm's service.

Honeywell Brown Ltd. Recording and controlling instruments.

Hydronyl Syndicate Ltd. Packing elements for distillation columns.

Metal Propellors Ltd. Distillation and fractionation equipment.

Newton Chambers & Co. Ltd. Fractionation columns and refining plant.

Shaw-Petrie Ltd. Pipework up to 30-inch diameter.

Whessoe Ltd. Fractionation and cracking plant, storage tanks, heat exchangers.

Engineering Exhibition

Alley & Maclellan Ltd. Air compressor, engines, valves for the oil industry.

Audley Engineering Co. Ltd. Plug valves for pipelines, lubricant for valves.

Babcock & Wilcox Ltd. Boilers, mechanical handling equipment, pressure vessels.

British Thomson-Houstin Co. Ltd. Electrical and mechanical equipment.

Brooks & Walker Ltd. Valves, flanges, engineers' tools.

Consolidated Pneumatic Tool Co. Ltd. Portable power tools.

English Electric Co. Ltd. Diesel engines, electrical plant.

Esso Petroleum Co. Ltd. Fuels, lubricants, and special petroleum products.

Evershed & Vignoles Ltd. Remote indicator and control equipment.

General Electric Co. Ltd. Electrical plant and equipment.

Germ Lubricants Ltd. Industrial lubricants and hydraulic oils.

G. A. Harvey & Co. (London) Ltd. Sheet metal and platework, steel furniture.

Imperial Chemical Industries Ltd. Tubes for oil refinery plant.

Richard Klinger Ltd. Packings, cocks, gauges, valves.

Metropolitan-Vickers Electrical Co. Ltd. Condensers, turbines, transformers.

Mond Nickel Co. Ltd. Nickel and nickel alloys.

Monsanto Chemicals Ltd. Hydraulic fluids, corrosion inhibitors.

Newman, Hender & Co. Ltd. Valves and fittings.

C. A. Parsons & Co. Ltd. Transformers and turbines, infra-red gas analyser.

Power Plant Co. Ltd. Helical, bevel and spur gear units.

A .Reynolds & Co. Ltd. Circuit breakers, electrical motors.

Rustin & Hornsby Ltd. Gas turbine running on load producing 1000 kw. for the exhibition, diesel engines.

Serck Radiators Ltd. Heat exchangers, oil coolers, radiators.

Shell-Mex & B.P. Ltd. Demonstrations of use of radio-active isotopes in wear measurement.

Sigmund Pumps Ltd. Centrifugal pumps, special pumps for refineries.

Stewarts & Lloyds Ltd. Pipework and tubes.

Stothert & Pitt Ltd. Fuel and lubricant pumps.

John Thompson Ltd. Valves, pipework, boilers.

United Steel Companies Ltd. Enquiry bureau for information concerning steels.

C. C. Wakefield & Co. Ltd. Industrial lubricants, cutting oils, lubricators.

G. & J. Weir Ltd. Pumps and power plant equipment.

Wilson Pipe Fittings Ltd. Cargo pipelines and tanker fittings.

Worthington-Simpson Ltd. Pumps—centrifugal, steam, power, vacuum.

Yorkshire Copper Works Ltd. Brass, Copper, and alloy tubes.

Welding Exhibition

English Electric Co. Ltd. Welding equipment and electrodes.

Lincoln Electric Co. Ltd. Welding equipment and electrodes.

Metropolitan-Vickers Electrical Co. Ltd. Welding equipment.

Murex Welding Processes Ltd. Electrodes and welding equipment.

Quasi-Arc Co. Ltd. Welding equipment and electrodes.

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COMPANY PRODUCTION

	July 1953 *Brl*
Kern Oil Co. Ltd.	
California	114,806
Trinidad	84,677
	Tons
Kuwait Oil Co. Ltd.	3,652,342
Qatar Petroleum Co. Ltd.	378,093
Iraq Petroleum Co. Ltd.	
Kirkuk	1,992,827
Zubair	261,388
Ain Zalah	111,005
	August 1953 *Brl*
Trinidad Petroleum Development Co.	280,080
Kern Oil Co. Ltd.	
California	112,890
Trinidad	84,908

Trinidad Refinery. In accordance with plans prepared by Trinidad Leaseholds Ltd. in conjunction with Universal Oil Products, the refinery at Pointe-a-Pierre has been extended for the improvement of Regent products. The main units in the construction consist of a vacuum unit for catalytic cracking feed preparation, a fluid catalytic cracking unit, a gasoline treating unit, and a gasoline rerun unit for handling the catalytic gasoline.

An attractive booklet which contains colour photographs of the plant may be obtained from Foster Wheeler Ltd., Ixworth Place, London, S.W.3.

The British Productivity Council, which "represents jointly management and workers in every type of industrial activity", has published an attractive booklet which describes the objective of the Council, the Council's programme, the organization, and its job ahead. Copies may be obtained, price sixpence, from the Council, 21, Tothill Street, London, S.W.1.

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WORLD DRILLING RECORD

The world's record depth for deep well drilling for crude oil was broken at the Ohio Oil Company's wildcat well in the Paloma field, 25 miles southwest of Bakersfield, California, on 20 August 1953.

The previous record was established in 1949 by the Superior Oil Company at Rock Springs, Wyoming, when a depth of 20,521 feet was reached. The California wildcat is being drilled in search of oil and gas below the present depths in the Paloma Field. Drilling may eventually go to about 21,000 feet. The Company are using an Ideal type 160 rig.

Much of the drilling has been done with diamond bits, both regular and coring, which made it possible to remove solid cores of the geological formations at various depths. Hundreds of these cores have been brought to the surface, and are expected to yield much geological information that will be of aid in future search for oil.

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Aerial Survey. A $250,000-contract for aerial photography and mapping approximately 85 per cent of Jordan has been awarded to Hunting Aerosurveys Ltd. 30,000 square miles of territory will be photographed at 1:50,000 scale, and 20,000 square miles from this photography is to be mapped on the same scale with 10-metre contour intervals.

High Vacuum Equipment. Three brochures dealing with rotary pumps, moisture and mercury vapour traps, and vacuum coating plant have just been published. Copies are obtainable from W. Edwards & Co. (London) Ltd., Worsley Bridge Road, Lower Sydenham, London, S.E.26. This company has also reprinted the whole of their series of "Vacuum Notes" advertisements in booklet form. Copies are available on application to the Company.

Foster Wheeler Ltd. have published a useful brochure which describes some of their power plants, petroleum refinery technique, and petrochemical processes which are widely used throughout the world. Copies may be obtained from the Company at Ixworth Place, London, S.W.3.

Nimoply 75 is the registered trade mark of composite metal sheets having Nimonic 75 on both sides of a copper base. The sheets have been developed for the combustion chamber linings of British gas turbines. The manufacturers (Henry Wiggin & Co. Ltd.) claim that this metal "sandwich" helps to dissipate the heat generated during combustion.

Suction Supply Conditions for Pumping Installations. This 28-page brochure by H. Hillier, O.B.E., M.I.Mech.E., M.I.Mar.E., reprinted from the transactions of the Institute of Marine Engineers, contains much useful data, tables, and some interesting photographs and diagrams. Copies are obtainable from G. & J. Weir Ltd., Cathcart, Glasgow.

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SITUATIONS VACANT

CHEMICAL ENGINEER required with specialized experience in the manufacture and application of bituminous waterproofing felt and fabrics by British firm for service in India under agreement. Salary in accordance with qualifications. Post offers good prospects to suitable man. Apply by letter only with full particulars, qualifications, experience, age, etc., to Geoffrey Turner & Co. Ltd., 7, St. Helen's Place, London, E.C.3.

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Secondhand S.A.E. Wear-Testing Machine, testpieces of two ½-inch wide cylindrical Timken rings of 1·9-inch diameter, rotating in the opposite directions with their cylindrical surfaces in contact under pressure. One shaft rotates at 1000 r.p.m., the other about 70 r.p.m. Maker—Society of Automobile Engineers, U.S.A. Write Box No. 1077 IP REVIEW.

FORTHCOMING MEETINGS

The Institute

The Friction of Solids. F. P. Bowden, Sc.D., F.R.S. (*University of Cambridge*). Redwood Lecture. At 26 Portland Place, London, W.1., 5.30 p.m. (*tea*, 5 *p.m.*), **14 October.**

Paint in the Petroleum Industry. H. B. Footner, B.Sc., Ph.D. (*The Shell Petroleum Co. Ltd.*). At 26 Portland Place, London W.1., 5.30 p.m. (*tea* 5 *p.m.*), **11 November.**

Fawley Branch

Distribution of World Oil Reserves. G. M. Lees, M.C., D.F.C., Ph.D., F.R.S. At Esso Recreation Club, Holbury, 7.30 p.m., **16 October.**

Gas Turbines. H. Farrington, A.M.I.Mech.E. At Esso Recreation Club, Holbury, 7.30 p.m., **13 November.**

London Branch

Geological Adventures. G. M. Lees, M.C., D.F.C., Ph.D., F.G.S., F.R.S. At 26 Portland Place, London, W.1., 5.30 p.m. (tea 5 p.m.), **21 October.**

Buffet Dance. At Paviour's Arms, Westminster, London, S.W.1., **13 November.**

South Eastern Branch

Annual Ball. At Tudor House, Bearsted, **16 October.**

Process Control Instrumentation. B. W. Balls. At King's Head Hotel, Rochester, 7.45 p.m., **3 November.**

South Wales Branch

Distribution of Petroleum in the U.K. G. H. Worth. At National Oil Refineries Training Centre, Llandarcy, 5.30 p.m., **5 November.**

Stanlow Branch

Discovery and Development of an Oilfield. H. R. Lovely, A.R.S.M., F.G.S. At Grosvenor Hotel, Chester, 7.30 p.m., **21 October.**

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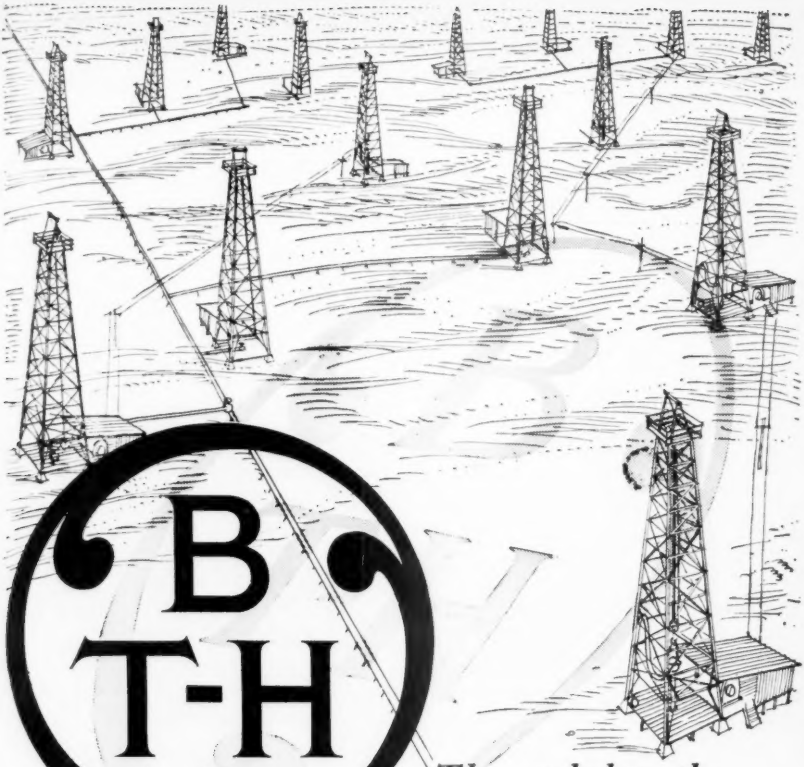

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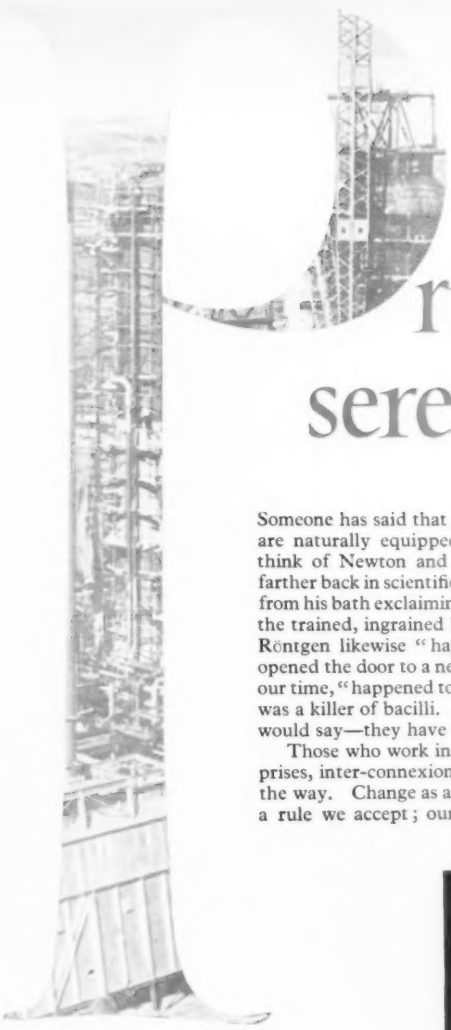

Princes of serendipity

Someone has said that it cannot be accepted that scientists are naturally equipped with serendipity. But when we think of Newton and the apple falling on his head and farther back in scientific history, a Greek gentleman leaping from his bath exclaiming "Eureka", then can we doubt that the trained, ingrained habit of observation is ever asleep? Röntgen likewise "happened to notice" something that opened the door to a new world of physics. Fleming, too, in our time, "happened to notice" that a rare penicillin mould was a killer of bacilli. Princes of serendipity—kings some would say—they have their conscientious liegemen to-day.

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